# U.S. Environmental Protection Agency
# Science Advisory Board
# COVID-19 Review Panel

Public Teleconference

April 30, 2020

1:00 pm - 5:00 pm (Eastern Time)

# WELCOME AND MEETING PURPOSE

Dr. Zaida Figueroa
Designated Federal Officer
EPA SAB Staff Office

Mr. Thomas Brennan
Director, EPA SAB Staff Office

Dr. Michael Honeycutt
Chair, SAB COVID-19 Review Panel

# AGENDA

**Purpose:** The Science Advisory Board (SAB) COVID-19 Review Panel will hold a public teleconference to receive an agency briefing, review charge questions and EPA's document titled: "Identifying Research Needs to Address the Environmental and Human Health Impacts of COVID-19."

| | | |
|---|---|---|
| 1:00 p.m. Eastern Time | **Convene Meeting** | Dr. Zaida Figueroa, Designated Federal Officer, SAB Staff Office |
| 1:05 p.m. | **Welcome and Purpose of the Teleconference** | Mr. Thomas Brennan, Director, SAB Staff Office<br><br>Dr. Michael Honeycutt, Chair, COVID-19 Review Panel |
| 1:15 p.m. | **Review of Agenda** | Dr. Michael Honeycutt |

*Actual times may vary from those indicated on this agenda based on discussions.

# AGENDA

1:20 p.m. **EPA Presentations**

| | |
|---|---|
| Office of Research and Development | Dr. Jennifer Orme-Zavaleta,<br>Principal Deputy Assistant Administrator for Science,<br>EPA Science Advisor |
| | Dr. Gregory Sayles,<br>Director, Center for Environmental Solutions<br>and Emergency Response |
| Office of Water | Ms. Charlotte Bertrand,<br>Deputy Assistant Administrator for Water |
| Office of Land and Emergency Management | Ms. Becki Clark,<br>Deputy Director, Office of Emergency Management |
| Office of Chemical Safety and Pollution Prevention | Mr. Rick Keigwin,<br>Director, Office of Pesticide Programs |

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# AGENDA

| | | |
|---|---|---|
| 2:35 p.m. | **Review of Charge Questions** | Dr. Michael Honeycutt |
| 2:45 p.m. | **Panel Discussion** | Dr. Michael Honeycutt and COVID-19 Review Panel Members |
| 4:50 p.m. | **Summary and Next Steps** | Dr. Michael Honeycutt |
| 5:00 p.m. | **Adjourned Meeting** | Dr. Zaida Figueroa |

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# EPA PRESENTATIONS

**U.S. Environmental Protection Agency**
**Science Advisory Board**
**COVID-19 Review Panel**

Public Teleconference
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# Dr. Jennifer Orme-Zavaleta
# Principal Deputy Assistant Administrator for Science, EPA Science Advisor

Office of Research and Development

# Dr. Gregory Sayles
# Director, Center for Environmental Solutions and Emergency Response

Office of Research and Development

# Science/Research Questions, Research Projects, and Charge

Presentation to the SAB COVID-19 Review Panel

April 30, 2020

# Building the Science/Research Questions Table

- EPA has robust capabilities to respond to environmental emergencies and addressing biological contamination. The world continues to learn much about COVID-19 - we also have the expertise to add to that knowledge, especially in the areas of exposure and cleaning and disinfection.
- EPA Administrator asked for a summary, relevant to the Agency's role in response to the pandemic, on:
  - Current State of Knowledge and Capabilities
  - Research Questions that Can Enhance Knowledge and Capabilities
- Input was gathered from subject matter experts from across the Agency.

# What's in the Table?

Page 1 of the table to illustrate how the table is organized

**U.S. EPA – COVID-19 Science/Research Question List (April 20, 2020)**

(Note: Yellow highlighting indicates where research efforts are already initiated within ORD)

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Environmental Disinfection | • EPA List N - Disinfectants for Use Against SARS-CoV-2 – lists many disinfectants as effective for use against SARS-CoV-2 on pre-cleaned, hard, non-porous environmental surfaces.<br>▪ Narrower list of products for porous materials.<br>▪ Narrower list of products for use as fogs, mists, vapors, or gases for volumetric disinfection.<br>• The stringency of the registration process provides a high degree of confidence in the effectiveness of these products when used according to the product label (https://www.epa.gov/pesticide-registration/efficacy-requirements-antimicrobial-pesticides)<br>• EPA uses standard laboratory methods (e.g., ASTM E1053-20 and ASTM E2197-17) to quantitatively evaluate the performance of disinfectants against viruses, and which are currently considered suitable for evaluating SARS-CoV-2 claims.<br>• Registered disinfectants do not require confirmatory sampling (post-application to ensure disinfection is achieved). (https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf)<br>• Enveloped viruses (such as SARS-CoV-2, the virus that causes COVID-19)) are generally more susceptible to disinfection than non-enveloped viruses, vegetative bacteria, and bacterial spores.[1,2,3]<br>• According to technical support requests that EPA has been involved with, the availability of disinfectants may be limited in supply in some areas. Alternative disinfection methods and products are being sought in these instances. | Short-Term<br>• Can basic cleaning techniques (e.g., using soap/water) alone be effective for surfaces to reduce environmental exposure to SARS-CoV-2?<br>• How effective are devices such as UV, ozone generators or steam devices at reducing or eliminating exposure to SARS-CoV-2 from surfaces or objects?<br>• What available disinfection methods can be effective for complex and difficult to disinfect areas/surfaces (such as porous materials, soft surfaces, and HVACs)? What are alternative disinfection methods, if such methods are not readily available or efficacious for an area?<br>• What are readily available alternative disinfectants (not currently on EPA List N) for large-scale or special situation use and by what methods can these disinfectants be applied effectively?<br>• Do methods of application of List N products via fogging and/or electrostatic spraying provide the necessary contact time on surfaces to be efficacious against SARS-CoV-2?<br>• How effective are products that claim to offer residual/long-term (e.g., hours to months) ability to reduce potential exposure risk to SARS-CoV-2?<br>• What disinfection methods (including using List N products) are suitable for residential and business-owner conducted disinfection?<br>• How susceptible to disinfectants are each of the human coronavirus isolates used for antimicrobial product registration, SARS-CoV and SARS-CoV-2? This comparative research may lead to the use of a safer-to-handle surrogate virus for future regulatory and research purposes, thus facilitating additional product and technology development. |

# ORD Research Underway

This month, ORD initiated applied research to enhance the nation's ability to respond to the current response in the weeks and months ahead.

***Research Topics and Projects:***

**Cleanup and Disinfection Evaluation**

- Surface Sampling Efficiency
- Real-World Surface Disinfection
- Long-Lasting Disinfectants
- Alternative Disinfection Devices
- Rapid Viability Polymerase Chain Reaction (RV-PCR) CoV-2 Assay
- Personal Protective Equipment (PPE) Disinfection

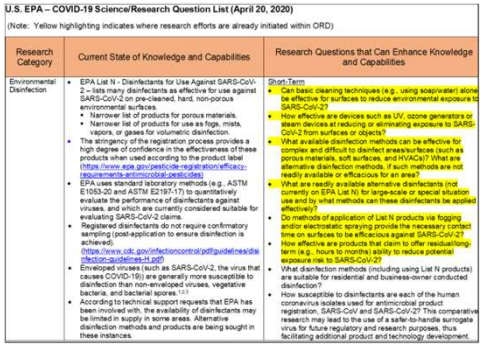
**Wastewater Virus Monitoring and Detection**

- Sewage Virus Levels for Assessing Community Infection Rate
- Live Virus Levels in Sewage and Effectiveness of Wastewater Treatment

**Salivary Antibody Assay Development**

# Charge Questions

1. Within each research category, please discuss whether there is sufficient clarity to indicate how addressing a research question might inform Agency activities related to the SARS-CoV-2 pandemic? Specifically,
   a) Which research questions within a category are particularly suited to EPA's mission and will have the most impact on EPA's role in responding to the SARS-CoV-2 pandemic?
   b) Are there research questions that could more effectively be addressed by another Federal partner, the private sector, academia or some combination?
2. Within each research category, please identify if there are other research questions that have not been identified by the Agency, that have the potential to refine or improve our understanding and further support its role with respect to the pandemic.
3. Within a research category, EPA roughly identified what research could be accomplished in the short-term, and what would be longer-term efforts. Within each research category, are there other considerations that might impact prioritization? How might research be prioritized across the landscape of research categories that have been identified?
4. Are there any other important categories of research, focused on the Agency's role in responding to the SARS-CoV-2 pandemic, that are not captured in the existing table? If so, please discuss the current state of knowledge in the research category and identify what research would be relevant and inform EPA's efforts. Please provide some sense of prioritization and whether the effort is a short-or-long term research effort.



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# REVIEW OF CHARGE QUESTIONS

Dr. Michael Honeycutt
Chair
SAB COVID-19 Review Panel

# CHARGE QUESTION 1

1. Within each research category, please discuss whether there is sufficient clarity to indicate how addressing a research question might inform Agency activities related to the SARS-CoV-2 pandemic? Specifically,

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# CHARGE QUESTION 2

2. Within each research category, please identify if there are other research questions that have not been identified by the Agency, that have the potential to refine or improve our understanding and further support its role with respect to the pandemic.

# CHARGE QUESTION 3

3. Within a research category, EPA roughly identified what research could be accomplished in the short-term, and what would be longer-term efforts. Within each research category, are there other considerations that might impact prioritization? How might research be prioritized across the landscape of research categories that have been identified?

# CHARGE QUESTION 4

4. Are there any other important categories of research, focused on the Agency's role in responding to the SARS-CoV-2 pandemic, that are not captured in the existing table? If so, please discuss the current state of knowledge in the research category and identify what research would be relevant and inform EPA's efforts. Please provide some sense of prioritization and whether the effort is a short-or-long term research effort.

# EPA's Document: Identification of Research Needs to Address the Environmental and Human Health Impacts of COVID-19

## Research Categories

(1) Environmental Disinfection
(2) Environmental Sample Collection Methods
(3) Environmental Sample Analysis
(4) Environmental Stability/Persistence on Surfaces
(5) Environmental Exposure
(6) Water/Wastewater
(7) Air
(8) Environmental Factors affecting transmission and severity of COVID-19
(9) Human Health Factors affecting transmission and severity of COVID-19
(10) Personal Protective Equipment (PPE)
(11) Human Health Risks of Exposure to Disinfectants

# CURRENTLY ON BREAK

**U.S. Environmental Protection Agency**
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# PANEL DISCUSSION

Dr. Michael Honeycutt
Chair
SAB COVID-19 Review Panel

# EPA's Document: Identification of Research Needs to Address the Environmental and Human Health Impacts of COVID-19

## Research Categories

(1) Environmental Disinfection
(2) Environmental Sample Collection Methods
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| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| | | <u>Long-Term</u><br>• Are there situations where environmental disinfection of surfaces or objects may not be effective to reduce or eliminate potential exposure to SARS-CoV-2?<br>  ○ In situations where the frequency of recontamination is high, how often is disinfection needed to effectively reduce or eliminate potential exposure to SARS-CoV-2?<br>  ○ If SARS-CoV-2 is airborne and continues to settle onto surfaces (e.g., after surface disinfection), does disinfection of surfaces alone effectively reduce potential exposure to SARS-CoV-2?<br>• How effective are surface coatings impregnated with antimicrobials or other antimicrobial surfaces (e.g. copper) in reducing or eliminating exposure to SARS-CoV-2 and how should disinfectants be used in combination with these treated surfaces? |

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Environmental Sample Collection Methods | • Studies have reported detection of coronavirus RNA on surfaces by environmental sampling.[4,5,6,7,8,9]<br>• The detection of coronavirus RNA does not equate to an exposure risk. RNA detection does not confirm that infectious virus is present.<br>• Infectious dose combined with exposure is used to estimate public health risk. Environmental sampling may inform potential exposure.[10]<br>• Researchers believe that the infectious dose for SARS-CoV-2 is less than that for SARS (estimated for SARS as an average of 240 viral particles).[11,12]<br>• The efficiency of environmental sampling (e.g., of surfaces) for viruses is typically very low; detection limits are generally higher than infectious dose and thus higher than required to adequately assess potential risk.[13]<br>• Due to the sampling inefficiencies for viruses on environmental surfaces, sampling would not be effective at confirming the efficacy of a registered disinfectant or at determining potential exposure risk prior to disinfection.<br>• Negative sampling results cannot be equated with the absence of viable virus.[10]<br>• Registered disinfectants are routinely and appropriately used without confirmatory sampling (post-application to ensure disinfection is achieved) (https://www.cdc.gov/infectioncontrol/pdf/guidelines/disinfection-guidelines-H.pdf) | Short-Term<br>• Under what situations does environmental contamination need to be assessed? (e.g., when is it useful to enhance or enable decision making.)<br>• What methods (e.g., swabs, wipes, material types) are most appropriate for surface sample collection for SARS-CoV-2?<br>• What are the detection limits and sample collection efficiencies specifically for SARS-CoV-2 for various environmental sample collection methods?<br>• What environmental sampling strategy(ies) (including number of samples, sample locations, frequency of sampling, and timing of sampling) will provide the most effective characterization of the presence/absence of SAR-CoV-2 on both non-porous and porous surfaces? |

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
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| Environmental Sample Analysis[14] | • Molecular methods (e.g., reverse transcription polymerase chain reaction, RT-PCR) are rapid (less than a day), available and provide specific detection of the virus; however, do not indicate viability or infectivity.[15]<br>• As noted by the National Academies of Sciences, "Studies that rely on PCR to detect the presence of viral RNA may not represent viable virus in sufficient amounts to produce infection."[16]<br>• After disinfection with an EPA List N product per the label's instructions, it is possible that inactive viral remnants will remain on the surface.<br>• Viral remnants detected from environmental sampling via molecular analysis methods do not indicate the presence of infectious virus (i.e., false positives).<br>• The tissue culture-based method provides information on the viability of the virus; however, this method is not specific for SARS-CoV-2. Confirming viability and infectivity requires running a 4-7 day, tissue-based culture method. | <u>Short-Term</u><br>• What are the SARS-CoV-2 sample analysis objectives (adequate specificity, limits of detection, viability assessment, turnaround time) and which methods are most suitable or can be developed to meet those objectives?<br>• What are the most appropriate sample custody, preservation, transport, and storage conditions to maintain sample viability prior to analysis for SARS-CoV-2?<br>• What is the current laboratory capability and capacity for molecular and viability analysis for SARS-CoV-2 and what method improvements can be made to increase capability/capacity? How does this reflect on the required environmental sample analysis needs? |

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Environmental Stability/Persistence on Surfaces | • Viable SARS-CoV-2 can persist on plastic and stainless-steel surfaces for up to 3 days (at 21-23°C, 40% RH), with a half-life of 13-16 hours.[17]<br>• Experience with other coronaviruses suggests that viable SARS-CoV-2 may persist on other surfaces up to several days, suggesting surfaces may be potential sources of exposure.[18,19,20]<br>• Lower temperature (4-6℃) and moderate humidity (~50% RH) promote longer virus survival on surfaces.[21]<br>• SARS decay rates increase as temperature increases. Low (<30%) and high (>80%) humidity also increase decay rates.[21]<br>• Testing with SARS and other enveloped viruses suggests that heat can accelerate virus decay on surfaces and in liquids.[22]<br>• Presence of viral RNA or viable virus on surfaces does not necessarily imply exposure risk to the individual.[23] | <u>Short-Term</u><br>• How long does SARS-CoV-2 remain active on frequently touched surfaces (e.g., escalator & subway hand holds, railings, door handles, etc.) as a function of environmental conditions?<br>  ○ How does temperature and humidity impact persistence indoors?<br>  ○ How long does SARS CoV-2 remain viable on surfaces and ambient air in outdoor conditions such as direct sunlight?<br>  ○ How long can SARS-CoV-2 remain viable on fomites (e.g., dust)?<br>  ○ How long can SARS-CoV-2 remain viable on mail or clothing, and does it pose a take-home risk?<br>• Can alternate environmental conditions (heat and humidity) be used to effectively reduce or eliminate the presence of SARS-CoV-2 on environmental surfaces? |

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Environmental Exposure | • Contact transmission and inhalation and/or oral exposure to respiratory droplets produced when an infected person coughs or sneezes are thought to be the primary routes of transmission.[24,25,26]<br>• There is a potential for exposure through touching contaminated surfaces and then touching of the mouth, nose or eyes, however this is not considered a primary route of exposure.[24,25,26]<br>• Surfaces and objects frequently touched by multiple people, including but not limited to doorknobs, handrails, light switches, gas pumps, etc. have a higher potential as a source for surface exposure. Walls, ceilings, mirrors, and floors are considered lower touch (and lower exposure potential) surfaces.[27] | Short-Term<br>• How effective are sampling and analysis methods for assessing potential risk from environmental exposure? What improvements are necessary?<br>• What measures can be used to mitigate environmental exposure to SARS-CoV-2?<br>• Which exposure scenarios pose the highest potential risk for individuals self-isolated at home (e.g., shopping, handling mail, outdoor exercise, etc.)?<br>Long-Term<br>• If SARS-CoV-2 settle on carpets, clothing, or other objects, does it present a hand-to-mouth hazard?<br>• Considering infectious dose and transmissibility, what amount of SARS-CoV-2 on widely prevalent surfaces poses a risk to public health? |

# Inhalation as a Probable Important (perhaps Predominant) Source of COVID-19 Infection

**Michael A Jayjock, Ph.D  CIH ad hoc Panel Member**

Presented in the USEPA Science Advisory Board Review Meeting: Identifying Research Needs to Address the Environmental and Human Health Impacts of COVID-19

Virtual Meeting

April 30, 2020

# Exposure Assessment is Inextricably Connected to Hazard Assessment

- Risk = *f* (Exposure)(Hazard/Exposure)
- Hazard/Exposure = Potency
- One must know the critical metrics of Potency to devise the proper metrics of Exposure and Risk
- IF the Hazard of SARS-CoV2 (COVID19) comes predominantly from **droplets** => surfaces => hands => upper respiratory tract THEN this dictates the scope and manner of testing.
- IF, however, **inhalation of aerosol** is a significant or dominant source THEN it needs to be tested.

# Evidence for the importance (perhaps predominance) of Inhalation for SAR-Cov-2 causing Human COVID-19

- In a review article on influenza virus, Tellier (2006)[1] reports a **40 to 500 fold** difference in **human** infectious dose ($HID_{50}$) between study data with aerosol inoculated subjects[2] compared to a different study in which the inoculation done was via intranasal drops[3]. That is, inhalation dose was **an order of magnitude or two** more infectious per administered viral unit.

- The influenza disease observed in **human** study participants infected experimentally by **intranasal drops was reportedly milder, with a longer incubation time and usually no involvement of the lower respiratory tract.**[3]

- For obvious reasons of SAFETY, these findings reportedly led to the adoption of intranasal drop inoculation as the standard procedure in **human** experimental infections with influenza virus.[3]


1. Tellier R (2006) Review of aerosol transmission of influenza A virus. Emerg Infect Dis 12: 1657–1662
2. Alford RH, Kasel JA, Gerone PJ, Knight V. Human influenza resulting from aerosol inhalation. Proc Soc Exp Biol Med. 1966;122:800–4
3 Douglas RG. Influenza in man. In: Kilbourne ED, editor. The influenza viruses and influenza. New York: Academic Press; 1975. p. 375–447)
4. Little JW, Douglas RG Jr, Hall WJ, Roth FK. Attenuated influenza produced by experimental intranasal inoculation. J Med Virol. 1979;3:177–88

# How Likely is Aerosol Exposure to SARS-CoV2? 1 of 3 (adapted from Nicas, 2020)[1]

- If an airborne particle of mostly water is smaller than 10 microns, it can penetrate all the way down to the pulmonary (alveolar) region of the lung.
- When we cough, sneeze, speak or simply exhale, we emit a *continuum* of particle sizes ranging from less than 1 micron to over 1,400 microns.
- A 2009 study[2] found that **half** the particles emitted by healthy subjects were less than 8 microns. It also found that many more particles were emitted in a cough compared to speaking.


1. Nicas, 2020: Emission and Dispersion of Infectious Particles in Air, Slides and Narration. Mark Nicas, PhD, MPH, CIH Emeritus Adjunct Professor Environmental Health Sciences Division School of Public Health University of California - Berkeley
2. CYH Chao, et al., Aerosol Science Vol. 40, pp 122-133

# How Likely is Aerosol Exposure to SARS-CoV2? 2 of 3 (adapted from Nicas, 2020)

- In a recent study[1], particles emitted by subjects with influenza were collected in two size fractions – less than 5 microns and greater than 5 microns. The viral RNA content was quantified by a standard PCR method.
- Based on the particle size data for human-emitted aerosol, we expect only a tiny percentage of the total fluid volume in emitted particles to be contained in those smaller than 5 microns, yet 90% of the virus particles were found in these small (respirable) particles. Remember, these particle can make it to the alveoli.
- In another similar study[2], particles from subjects with influenza were collected in three fractions: less than 1 micro, 1 to 4 microns, and greater than 4 microns. The majority (65%) of virus particles were found in the fraction less than 4 microns.


1. DK Milton, et. al., PLoS Pathogens, Volume 9(3), e1003205, March 2013: "Influenza Virus Aerosols in Human Exhaled Breath"
2. WG Lindsley, et al., PLoS ONE, Volume 5(11), e15100, November 2010: "Measurements of Airborne Influenza Virus in Aerosol Particles from Human Coughs"

# How Likely is Aerosol Exposure to SARS-CoV2? 3 of 3 (adapted from Nicas, 2020)

- How long do 5 micron particles stay in air and how far can they go?
- If a 5 micron particle were emitted into still air at 5 feet above floor level, it would take about 33 minutes to settle.
- During that settling time, can a 5-micron particle travel more than 6 feet? Ans: *It can* and *it will*.
- A 2014 study[1] presented a fluid mechanics and visual analysis of the path and distance traveled by particles in a cough. According to the authors, particles less than 10 microns in diameter "would remain suspended in a cough cloud meters away from the cougher."

1. L Bourouiba et. al. (2014), Journal of Fluid Mechanics, Volume 745, pp 537-563

# The Importance of Measuring Virus Exposure Through Aerosol

- In the Charge document we are told: "Researchers believe that the infectious dose for SARS-CoV-2 is less than that for SARS (estimated for SARS as an average of 240 viral particles)"[1,2]
- I (Jayjock) could not find the value of 240 viral particles in either of these papers but both studies did state that the animals were dosed via nasal deposition.
- What if this value of 240 for nasal dosing were divided by a factor of 40 to 500 for animals or humans dosed via inhalation? (see Slide 2)
- There is every reason to believe that aerosol exposure is critical in the risk assessment of COVID19 and should be included in any planed research program.


1. De Albuquerque, N.; Baig, E.; Ma, X.; Zhang, J.; He, W.; Rowe, A.; Habal, M.; Liu, M.; Shalev, I.; Downey, G. P.; Gorczynski, R.; Butany, J.; Leibowitz, J.; Weiss, S. R.; McGilvray, I. D.; Phillips, M. J.; Fish, E. N.; Levy, G. A., Murine hepatitis virus strain 1 produces a clinically relevant model of severe acute respiratory syndrome in A/J mice. J Virol 2006, 80 (21), 10382-94.
2. Dediego, M. L.; Pewe, L.; Alvarez, E.; Rejas, M. T.; Perlman, S.; Enjuanes, L., Pathogenicity of severe acute respiratory coronavirus deletion mutants in hACE-2 transgenic mice. Virology 2008, 376 (2), 379-389.

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Water/ Wastewater | • Based on existing CDC information there is no indication that water or wastewater exposures pose a significant risk to human health.[28]<br>• 53% of stool specimens from infected patients test positive for the virus, however, it has not been confirmed to be viable/infectious virus.<br>• There is limited research to suggest that the virus might be transmitted via the fecal-oral route.[29,30]<br>• SARS-CoV-2 can be inactivated using sodium hypochlorite and other disinfectants recommended by EPA.[27] | Short-Term<br>• What uncertainties exist and what refinements are necessary to more accurately quantifying SARS-CoV-2 in the various water types (i.e., drinking water, wastewater, surface water, and groundwater)?<br>Long-Term<br>• What is SARS CoV-2 persistence in untreated water (i.e., sewage or wastewater before final disinfection, surface water, and groundwater)?<br>• Do commonly used POTW biosolids stabilization methods effectively deactivate SARS-CoV-2? |

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|---|---|---|
| Air | • Respiratory droplets produced when an infected person coughs or sneezes are thought to be a primary route of transmission.[31,32]<br>• Recent reports indicate that SARS-CoV-2 can remain viable in aerosols for up to three hours.[33]<br>• Research indicates that aerosols from a sneeze or cough could take an hour to settle and possibly longer for smaller aerosols.[34] | <u>Short-Term (non-healthcare setting)</u><br>• How long does the virus remain viable in ambient air (as a function of temperature, humidity, UV, precipitation)?<br>• Can air vented outside from contaminated indoor environments carry significant infectious viral load outdoors, particularly in dense urban environments, or in cases of re-entrainment of exhausted air back indoors?<br>• Are there potential indoor sources that can contaminate areas or lead directly to exposure, through aerosolization? (e.g., drain traps, toilet flushing, vacuuming, dusting, wiping, re-aerosolization from surfaces)<br>• Does SARS-CoV-2 remain viable after traveling through an HVAC system? How does the answer vary for different types of HVAC systems in different types of buildings or indoor environments (hospitals, large commercial buildings, residences, schools, airplanes, trains, buses)?<br><u>Long-Term (non-healthcare setting)</u><br>• If aerosol risks are excessive, how can aerosol exposure indoors be reduced?<br>• What precautions, if any, must be taken when cleaning or replacing different types of HVAC or portable air cleaner filters?<br>• Can airborne SARS-CoV-2 deposit in water bodies and lead to exposure via contaminated water?<br>• Does home vacuuming remove SARS-CoV-2 from the surface or cause it to aerosolize? |

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|---|---|---|
| Environmental Factors affecting transmission and severity of COVID-19 | • We know that certain types and levels of air pollution exposure increase hospital admissions for respiratory infections including influenza. | Long-Term<br>• Can particulate matter in the atmosphere serve as a vehicle for the transmission of SARS-CoV-2?<br>• Does exposure to air pollutants, including wildland fire smoke or other air pollutants (e.g. ozone, particulate matter, diesel exhaust, pollen) increase the susceptibility to respiratory viruses like SARS-CoV-2? Or exacerbate existing COVID-19 infection?<br>• Does ambient or indoor temperature or humidity affect the transmission of SARS-CoV-2 and severity of the COVID-19 illness? |

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|---|---|---|
| Human Health Risk Factors affecting transmission and severity of COVID-19 | The CDC maintains the COVID-19 website to provide the latest information on what is known about the disease, its transmission, impacts, and what individuals can do to protect themselves and to help stop the spread.<br><br>https://www.cdc.gov/coronavirus/2019-ncov/index.html | Long-Term<br>• Are there particular health risk factors (aside from pre-existing conditions) that make certain individuals or subpopulations more sensitive or vulnerable to COVID-19, e.g. characteristics of the built environment, seasonal allergies, chronic exposure to aerosolized pollutants, demographic conditions, etc.?<br>• Do factors, such as socioeconomic status, gender, race, stress, and characteristics of the built environment affect transmission of SARS-CoV-2 and severity of the COVID-19 illness? |

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|---|---|---|
| Personal Protective Equipment (PPE) | Appropriate PPE decontamination procedures are necessary. Guidance for PPE can be found on OSHA and CDC websites:<br>https://www.osha.gov/SLTC/covid-19/standards.html<br><br>https://www.cdc.gov/coronavirus/2019-ncov/community/organizations/businesses-employers.html<br><br>https://www.cdc.gov/coronavirus/2019-ncov/hcp/healthcare-supply-ppe-index.html<br><br>https://www.cdc.gov/coronavirus/2019-ncov/hcp/ppe-strategy/index.html | Short-Term<br>• What are recommended procedures for disinfecting PPE for the purposes of reuse?<br>• How many times can it be disinfected before it must be disposed?<br>• Does hand sanitizer work on disposable gloves so they could be reused? This would include suits, N95s, gloves, and booties. |

| Research Category | Current State of Knowledge and Capabilities | Research Questions that Can Enhance Knowledge and Capabilities |
|---|---|---|
| Human Health Risks of Exposure to Disinfectants | • Exposure to disinfectants can pose risks to children and sensitive subpopulations, including those with respiratory sensitivity.<br>• The CDC has specific guidance for communities, schools, workplaces, and events (https://www.cdc.gov/coronavirus/2019-ncov/community/index.html). For example, information on childcare facilities that remain open during the COVID-19 pandemic is available (https://www.cdc.gov/coronavirus/2019-ncov/community/schools-childcare/guidance-for-childcare.html)<br>• EPA's Office of Pesticide Programs conducts human health risk assessments for disinfectants using well-established, peer reviewed and science-based methodologies (https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/standard-operating-procedures-residential-pesticide).<br>• Disinfectants are currently undergoing registration review, the 15-year review cycle to determine whether they continue to meet the FIFRA standard for registration. | Long-Term<br>• Some additional research would allow for more refined estimates of exposure for post application exposures. For example, measurements on residue transfer for disinfectants applied to toys and floor surfaces, amount of mopping solution used and volatilization of disinfectants into indoor air would provide useful information for assessing the risk of children and other susceptible populations. Is there other exposure information that would be informative?<br>• The EPA has exposure data for trigger pump spray and hand-held spray wants (hand-held mechanical application). Are there any novel SARS-CoV-2 control application techniques (e.g., electrostatic sprayer) that would not be represented by the currently available exposure data?<br>• With regard to assessing risk to people with respiratory sensitivity, are there laboratory animal models or non-animal methods (e.g., *in vitro* or computational approaches) that would be useful? |

# SUMMARY AND NEXT STEPS

Dr. Michael Honeycutt
Chair
SAB COVID-19 Review Panel

# CLOSING REMARKS

Dr. Michael Honeycutt
Chair
SAB COVID-19 Review Panel

Dr. Zaida Figueroa
Designated Federal Officer
EPA SAB Staff Office

# MEETING ADJOURNED

**U.S. Environmental Protection Agency**
**Science Advisory Board**
**COVID-19 Review Panel**

Public Teleconference
April 30, 2020
1:00 pm - 5:00 pm (Eastern Time)